

NOTE ON PILOT-BALLOON FLIGHTS IN A THUNDERSTORM FORMATION.

By LIEUT. IVAN R. TANNEHILL.

[Dated: Fort Story, Va., Nov. 14, 1919.]

At Fort Monroe, Va., on August 30, 1919, at 3:00 p. m., a thunderstorm formation in the southwest appeared to be moving toward the northeast. This storm passed over the Fort with wind shifting to northwest at the surface at 4:01 p. m. Rain began lightly at 4:38 p. m. and later became heavy. Six pilot-balloon observations were made in front of, and under, the cloud. This note is a brief summary of those observations.

During the day the wind in the lower levels was brisk from the southwest and south-southwest, turning counter-

The six observations were taken at 3:00, 3:30, 3:45, 3:55, 4:03, and 4:15 p. m. The horizontal projections of the paths of these balloons are given in fig. 2. During this time the storm passed over the station and the wind shifted. At 3:00 p. m., there was intermittent thunder, nearly continuous. At 3:15 p. m., the top of the cumulus had mushroomed, had extended to the zenith, and was drifting rapidly toward the northeast. At 3:30 p. m., squall clouds were moving in from the southwest. At 3:45 p. m., there were upper clouds over the entire sky and the squall clouds reached the zenith. At 4:01 p. m., the wind shifted and at 4:38 p. m. rain began.

Figure 3 gives the march of direction and velocity from 3:00 p. m. to 4:15 p. m. from the six observations. After 3:00 p. m. the wind turned slowly clockwise in

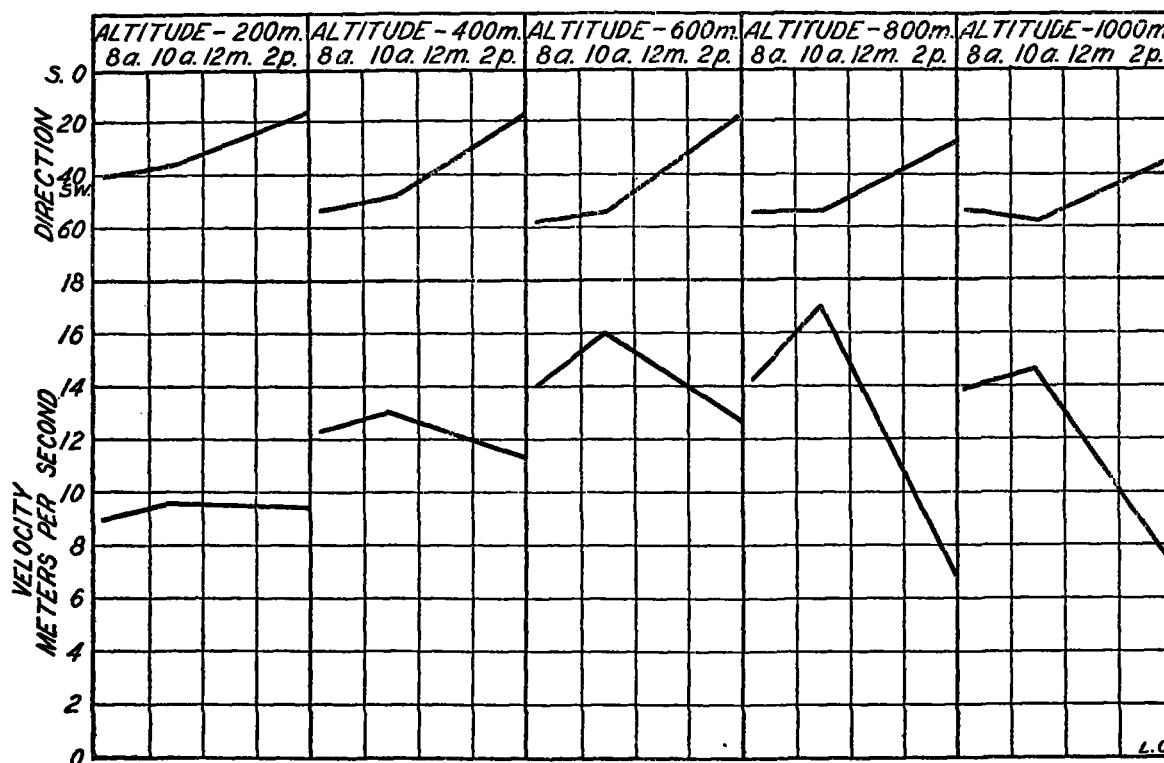


FIG. 1.—Velocity and direction of the wind during the day up to 3:30 p. m., for heights in 200-meter intervals.

clockwise. The velocity decreased rather rapidly aloft to a height of 1,000 meters, the decrease being most marked at 800 meters elevation. This probably occurred chiefly toward the time of the third observation at 3:00 p. m. Figure 1 shows the velocity and direction of the wind during the day up to 3:00 p. m., for heights in 200-meter intervals.

At 3:00 p. m. the pressure was 29.87 inches (sea level) and the temperature was 31° C. Upper-air observations were being made with one theodolite, but when it appeared that the thunderstorm would pass near the Fort men were sent to the distant station and two-theodolite observations were begun at 3:45 p. m.; base line 1,541 meters, azimuth 201°.

Until time of wind shift the balloons moved along the base line so that altitudes computed are not sufficiently accurate to represent in detail the vertical movements of the air. After wind shift the vertical movements appeared to be quite irregular.

the lower 600 meters until time of wind shift when it turned rapidly clockwise. The velocity continued to decrease in the first 600 meters and increased slowly above. Between 3:30 and 4:00 p. m. the decrease in velocity was marked and extended upward to 1,000 meters elevation, although occurring later at higher levels.

The northwest wind was most pronounced at an elevation of about 400 meters. At 1,000 meters there was little evidence of the changes taking place in lower levels. A study of these figures makes it obvious that the northwest wind flowed in over the surface and was strongest near the surface. The frictional drag probably accounts for the lighter wind at 200 meters than at 400 meters elevation, at the time of the wind shift.

This thunderstorm passed northwest of the station. At the Langley Field Meteorological Station, 9,000 meters north-northwest of the Fort Monroe Meteorological Station, the wind shifted at 3:30 p. m. and rain began at 4:20 p. m.

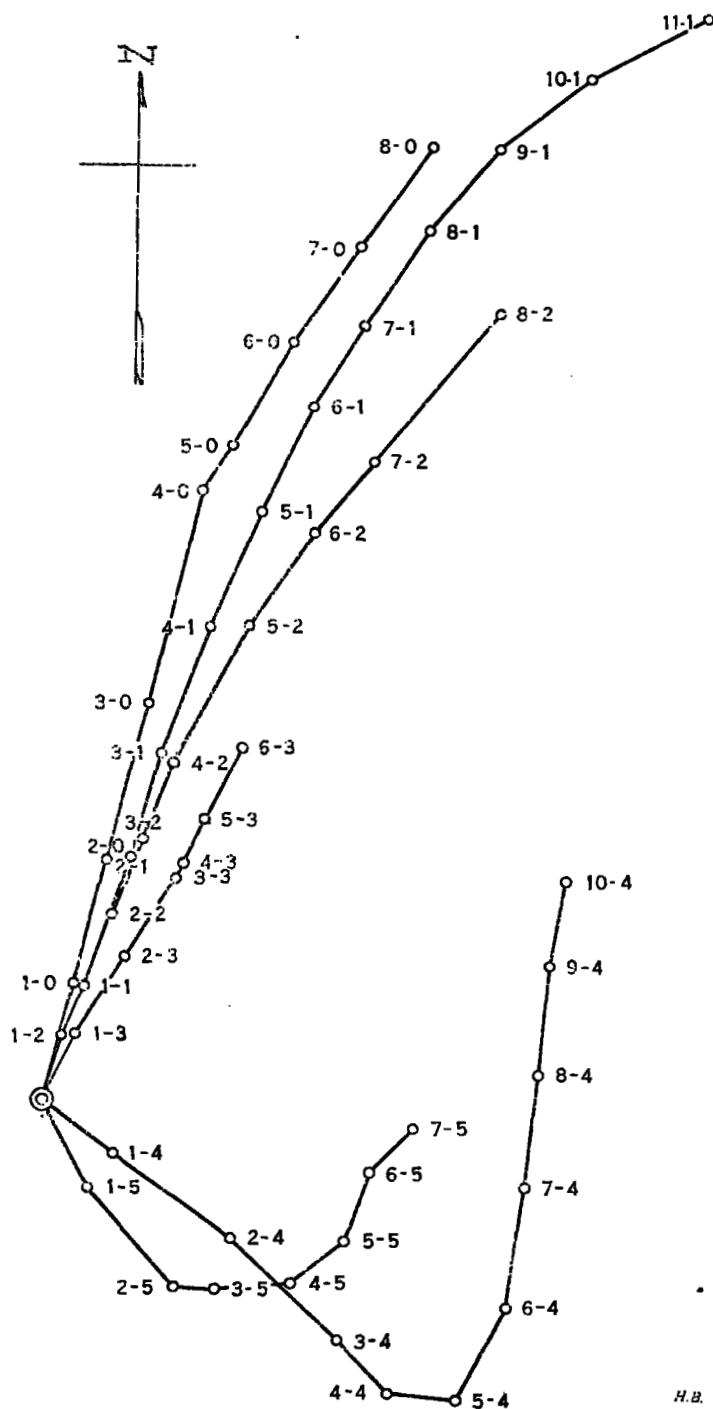


FIG. 2.—Horizontal projections of balloon paths.

These observations seem to indicate that the lull before the storm extends to heights of 800 to 1,000 meters and that the squall flows in over the surface. The clockwise turning of the wind during the passage of the storm is what would be expected from a counterclockwise whirl

with its southeast quadrant passing northeastward over the observer. It was impossible, on account of clouds, to get observations to heights exceeding 1,000 meters during this period.

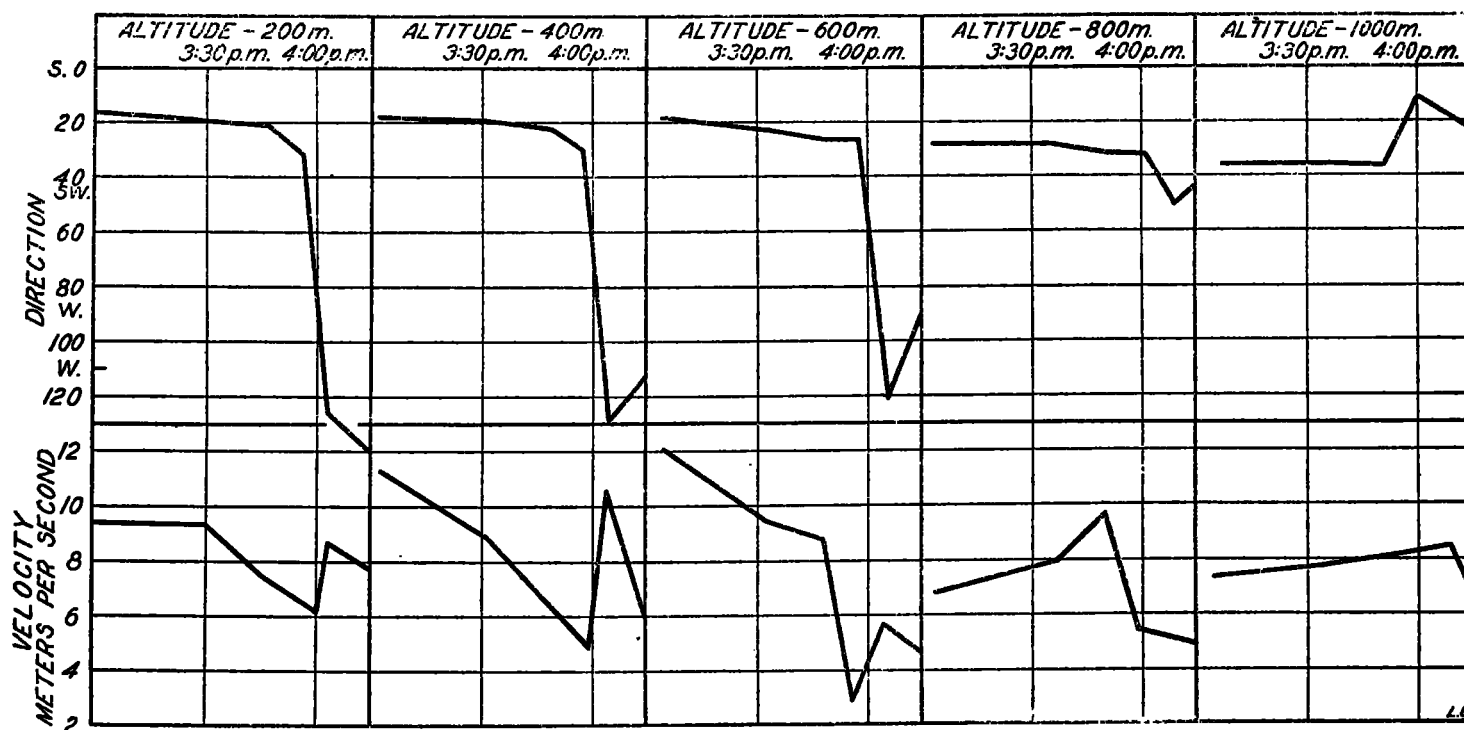


FIG. 3.—March of direction and velocity from 3:30 p. m. to 4:15 p. m. from the six observations.

WATERSPOUT OBSERVED AT SAN JUAN, PORTO RICO, SEPTEMBER 10, 1919.

By WILLIAM C. HAINES, Observer.

[Dated Weather Bureau, San Juan, P. R., Oct. 27, 1919.]

An exceptionally well-defined and magnificent waterspout was observed at San Juan, P. R., by a number of people on the evening of September 10. It occurred in connection with a thunderstorm which formed in the late afternoon to the north and northeast of the city and hung almost stationary until late in the evening.

When the waterspout was first observed at 4:45 p. m. by the writer, who was located at the Weather Bureau station approximately 1 mile east of the city, the funnel-shaped cloud extended from a dark mass of storm cloud on the outer edge of the thunderstorm proper to the surface of the ocean where a swirl of spray was plainly visible. The funnel-like cloud was nearly straight, although it was inclined from the vertical at an angle of from 25 to 30 degrees, the bottom portion extending toward the southwest away from the vicinity of the thunderstorm. (See Fig. 1.) The funnel increased very gradually in diameter from the cloud spray at the surface of the water until just before it entered the base cloud where it rapidly increased in size. The spout remained practically motionless until about 5:00 p. m. when it began to show evidences of dissolving about one-fourth the distance up the column; within a period of five minutes it had become entirely severed, the bottom portion and spray remaining visible for several seconds. (See Fig. 2.) The upper portion of the column gradually shortened and by 5:15 p. m. it had entirely emerged into the general base cloud. (See Fig. 3.) The waterspout formed to the northwest of the station at a distance estimated to be from 5 to 8 miles.

Several peals of thunder were heard between 5:00 p. m. and 5:15 p. m. Rain could be seen falling a short distance to the north, although none actually fell at the station. The clouds in the region of the thunderstorm were apparently from the northeast, while the cumulus and strato-cumulus clouds overhead and in other portions of the sky were from the southwest. The upper clouds during the day had been from the northwest, although none were visible at the time of occurrence of the waterspout. The wind was moderate and from the east during the afternoon until about 4:00 p. m. when it became light and shifted to the southwest and west and so continued during the prevalence of the thunderstorm.

A sharp lookout was kept during the evening but no other spout was observed. Unfortunately no photographs were taken of this waterspout by anybody as far as could be learned.

TWO WATERSPOUTS OBSERVED AT RABAT, MOROCCO, ON DECEMBER 18, 1917.

By J. PEYRIGUEY.¹

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Descriptions are given of two waterspouts associated with heavy cumulo-nimbus cloud, which came up from the Atlantic with a strong southwest wind. Both were at least about 350 meters long, and extended from the cloud to 50 meters above the surface. The first waterspout was about 4 meters in diameter, the second only about 1 meter. Subsequently a heavy thunderstorm was experienced.—R. C.

¹ Comptes Rendus, 166, Jan. 7, 1918, pp. 48-49.